

WHAT IS CLAIMED IS:

1. A lead zirconate titanate-based thin film,
wherein the film is an epitaxial crystal thin film
which has a chemical composition represented by the
5 general formula $Pb_{1-x} Ln_x Zr_y Ti_{1-y} O_3$ (wherein Ln
represents any one selected from the group consisting
of lanthanum, lanthanoid elements, niobium, calcium,
barium, strontium, iron, manganese and tin; and $0 \leq x < 1$,
 $0.43 \leq y \leq 0.65$) and whose orientation is {111}
10 (including orientations whose tilt angle from the
direction perpendicular to the substrate surface is
within 15°).
2. The lead zirconate titanate-based thin film
15 according to claim 1, wherein the orientation of the
film is (111) (including orientations whose tilt
angle from the direction perpendicular to the
substrate surface is within 15°).
- 20 3. The lead zirconate titanate-based thin film
according to claim 1, wherein the half-width of the
locking curve in the circumferential direction of X-
ray pole figure is within 30° .
- 25 4. The lead zirconate titanate-based thin film
according to claim 1, wherein the half-width of the
locking curve in the circumferential direction of X-

ray pole figure is within 15°.

5 5. The lead zirconate titanate-based thin film according to claim 1, wherein the half-width of the locking curve of the crystal is within 15°.

10 6. The lead zirconate titanate-based thin film according to claim 1, wherein the half-width of the locking curve of the crystal is within 5°.

7. The lead zirconate titanate-based thin film according to claim 1, wherein the half-width of the locking curve of the crystal is within 2°.

15 8. The lead zirconate titanate-based thin film according to claim 1, wherein the half-width of the locking curve of the crystal is within 1°.

20 9. A lead zirconate titanate-based thin film having a composition represented by the general formula $Pb_{1-x}Ln_xZr_yTi_{1-y}O_3$ (wherein Ln represents any one selected from the group consisting of lanthanum, lanthanoid elements, niobium, calcium, barium, strontium, iron, manganese and tin; $0 \leq x < 1$; and
25 $0.43 \leq y \leq 0.57$), wherein the relative permittivity - voltage characteristics of the film satisfy the following equation: $\Delta\epsilon/\Delta E \geq 3.0$, wherein $\Delta\epsilon$ is a change

in relative permittivity and ΔE is a change in electric field strength (kv/cm).

10. The lead zirconate titanate-based thin film
5 according to claim 9, wherein the relative permittivity - voltage characteristics satisfy the following equation: $\Delta\epsilon/\Delta E \geq 5.0$.

11. The lead zirconate titanate-based thin film
10 according to claim 9, wherein the film is an epitaxial film whose orientation is (111) or within 15° from (111).

12. The lead zirconate titanate-based thin film
15 according to claim 1 or 11, wherein the {111} face of the epitaxial film is orientated within a tilt angle of 5° (including 0°).

13. The lead zirconate titanate-based thin film
20 according to claim 1 or 12, wherein the {111} face of the epitaxial film is orientated within a tilt angle of 3° (including 0°).

14. The lead zirconate titanate-based thin film
25 according to claim 1 or 9, wherein silicon is used for the substrate.

15. The lead zirconate titanate-based thin film according to claim 14, wherein the silicon is (100) orientated.

5 16. The lead zirconate titanate-based thin film according to claim 14, wherein the silicon is (111) orientated.

10 17. The lead zirconate titanate-based thin film according to claim 1 or 9, wherein the film is formed by MOCVD;

15 18. The lead zirconate titanate-based thin film according to claim 1, wherein in the general formula $Pb_{1-x} Ln_x Zr_y Ti_{1-y} O_3$, $0.43 \leq y \leq 0.57$.

19. The lead zirconate titanate-based thin film according to claim 18, wherein in the general formula $Pb_{1-x} Ln_x Zr_y Ti_{1-y} O_3$, $0.45 \leq y \leq 0.55$.

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20. The lead zirconate titanate-based thin film according to claim 1 or 9, wherein the crystal structure is at least any one of tetragonal, cubic and rhombohedral crystals.

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21. The lead zirconate titanate-based thin film according to claim 20, wherein at least any two of

tetragonal, cubic and rhombohedral crystals coexist.

22. The lead zirconate titanate-based thin film
according to claim 1 or 9, wherein at least the
5 surface of the substrate is electrically conductive.

23. A lead zirconate titanate-based thin film,
wherein the film is an epitaxial crystal thin film
which has a chemical composition represented by the
10 general formula $Pb_{1-x} Ln_x Zr_{1-y} Ti_y O_3$ (wherein Ln
represents any one selected from the group consisting
of lanthanum, lanthanoid elements, niobium, calcium,
barium, strontium, iron, manganese and tin; and $0 \leq x < 1$,
 $0.40 \leq y \leq 0.65$), whose orientation is {111} (including
15 orientations whose tilt angle from the direction
perpendicular to the substrate surface is within 15°),
and in which at least any two of tetragonal, cubic
and rhombohedral crystals coexist.

20 24. The lead zirconate titanate-based thin film
according to claim 23, wherein in the general formula
 $Pb_{1-x} Ln_x Zr_{1-y} Ti_y O_3$, $0.43 \leq y \leq 0.57$.

25 25. A lead zirconate titanate-based epitaxial
thin film formed by MOCVD, wherein the film has a
chemical composition represented by the general
formula $Pb_{1-x} Ln_x Zr_{1-y} Ti_y O_3$ (wherein Ln represents any

one selected from the group consisting of lanthanum, lanthanoid elements, niobium, calcium, barium, strontium, iron, manganese and tin; and $0 \leq x < 1$, $0.43 \leq y \leq 0.65$) and its orientation is {111} (including
5 orientations whose tilt angle from the direction perpendicular to the substrate surface is within 15°).

26. A dielectric device, comprising the lead zirconate titanate-based thin film according to any
10 one of claims 1, 9, 23 and 25.

27. A piezoelectric device, comprising the lead zirconate titanate-based thin film according to any one of claims 1, 9, 23 and 25.

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28. An ink jet printer head, comprising the piezoelectric device according to claim 27.

29. A ferroelectric device, comprising the lead zirconate titanate-based thin film according to any
20 one of claims 1, 9, 23 and 25.

30. A pyroelectric device, comprising the lead zirconate titanate-based thin film according to any
25 one of claims 1, 9, 23 and 25.

31. A method of producing a lead zirconate

titanate-based thin film, wherein a crystal film
having a chemical composition represented by the
general formula $Pb_{1-x}Ln_xZr_{1-y}Ti_yO_3$ (wherein Ln
represents any one selected from the group consisting
5 of lanthanum, lanthanoid elements, niobium, calcium,
barium, strontium, iron, manganese and tin; and $0 \leq x < 1$,
 $0.43 \leq y \leq 0.65$) is epitaxially grown on a substrate at
least the surface of which has a {111} orientation or
orientation with a tilt angle within 15° from {111}
10 by MOCVD.

32. The method of producing a lead zirconate
titanate-based thin film according to claim 31,
wherein $0.45 \leq y \leq 0.57$.
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33. The method of producing a lead zirconate
titanate-based thin film according to claim 31,
wherein $0.43 \leq y \leq 0.55$.

20 34. A lead zirconate titanate-based thin film,
wherein the film is a crystal thin film which has a
chemical composition represented by the general
formula $Pb_{1-x}Ln_xZr_{1-y}Ti_yO_3$ (wherein Ln represents any
one selected from the group consisting of lanthanum,
25 lanthanoid elements, niobium, calcium, barium,
strontium, iron, manganese and tin; and $0 \leq x < 1$,
 $0.40 \leq y \leq 0.65$), whose orientation is {111} (including

orientations whose tilt angle from the direction perpendicular to the substrate surface is within 15°), and in which at least any two of tetragonal, cubic and rhombohedral crystals coexist.